Torsten Blanck

Cuora yunnanensis (BOULENGER, 1906), the Yunnan Box Turtle, Rediscovered after One-hundred Years?

Abstract

Cuora yunnanensis, the Yunnan box turtle, has been regarded as extinct since 1906. There is hardly any other species of turtle about which so little is known. In this paper, all specimens existing in scientific collections are redescribed. Furthermore, information on and pictures of a live specimen of *Cuora yunnanensis* are presented for the first time outside China, ninety-nine years after its original description. This data is compared with museum material. The possible point of origin and the taxonomic status of the species are discussed. Incorrect information originating from older literature is corrected.

Key words

Reptilia: Testudines: Cryptodira: Geoemydidae: *Cuora yunnanensis*; *Cyclemys yunnanensis*; BOULENGER, 1906; *Cuora pani*; *Chinemys reevesii*; living specimen; designation of lectotype.

Introduction and systematics

In 1906, GEORGE ALBERT BOULENGER, the then-curator of herpetology at the British Museum of Natural History (BMNH), published a paper titled „Descriptions of New Reptiles from Yunnan“ in the periodical, „Annals and Magazine of Natural History“ (London, Series 7, Issue 17), which included on page 567 the description of *Cyclemys yunnanensis.* This description was rather brief (three-quarters of a page) and did not include illustrations. SIEBENROCK (1909) followed the generic classification, but SMITH (1931) later transferred the species to the genus *Cuora.* POPE (1935) listed the taxon again as *Cyclemys yunnanensis,* but WERMUTH & MERTENS (1961) included it once more in *Cuora*.

Type series: BOULENGER's description does not make reference to a specific specimen, but rather refers to several specimens from Kunming and one specimen from Dongchuan. Most of his description is, however, no doubt based on specimen BMNH 1946.1.22.97 (formerly 1905.5.30.34). It is a female of 138.5 mm in carapace length (Fig. 1) from „Tongchuan fu“, the present-day Dongchuan (26°11'N, 103°03'E), a town some 130 km northeast of Kunming (25°02'N, 102°42'E) in the Chinese province of Yunnan. This specimen was the only one BOULENGER received from this locality for the British Museum of Natural History in London in 1905. It had been collected by Father F. J. DYMOND and acquired by Father JOHN GRAHAM. BOULENGER then received five additional male and juvenile specimens representing the same species (syntypes BMNH 1946.1.22.98, 1946.1.22.99, 1946.1.23.1, 1946.1.23.2 and 1946.1.23.3 [formerly BMNH 1906.5.29.2-6]) in 1906, a year after the original one (Figs. 2, 3 and 10). These five specimens originated from „Yunnan fu“, which is today known as Kunming (25°02'N, 102°43'E) and is the capital of Yunnan Province, China. All of these had been collected, respectively bought, presumably on a food market, by Father JOHN GRAHAM, but more on this subject will be said later. When these were received, BOULENGER had obviously already been busy formulating the definition of the new species on the basis of the female specimen BMNH 1946.1.22.97 from Dongchuan received in 1905. This explains why the larger part of his description, including his referring to a length of 140 mm and the

presence of only one lateral stripe on either side of the head, is based on this particular specimen. In contrast, no particular reference is made to the other specimens of *Cuora yunnanensis* in the collection of the BMNH other than in mentioning „several specimens of this very distinct species“ towards the end of the paper.

Based on these circumstances the present author suggests that for reasons of taxonomic correctness, BMNH 1946.1.22.97 be considered as the lectotype, whereas the syntypes BMNH 1946.1.22.98, 1946.1.22.99, 1946.1.23.1, 1946.1.23.2 and 1946.1.23.3 be classified as paralectotypes.

Almost all relevant papers published during the past 100 years make reference only to the specimens contained in the type series (BOULENGER 1906, SMITH 1931, POPE 1935, ERNST 1988, WANG & ZHAO 1998), and there are no indications that further specimens may exist in other museums as well. But this is precisely the case: STEINDACHNER (1906) acquired two more specimens with the locality „Yunnan fu“ (= Kunming) from W. H. F. ROSENBERG in London which he deposited in the Naturhistorisches Museum Vienna (NMW 29936.1-2; Fig. 4).

ROSENBERG was some kind of broker or dealer who purchased natural history objects from collectors and travellers and retailed them to museums (MCCARTHY pers. comm.). GRAHAM is likely to have sold him his remaining three specimens, which ROSENBERG then sold on to Vienna in 1906 and to Paris in 1907, respectively. The London material, on the other hand, had been donated directly by GRAHAM.

Thus, a male specimen with the locality „Yunnan fu“ (Kunming) also exists in the Muséum National d'Histoire Naturelle (MNHN) in Paris (MNHN 1907-10; Fig. 5). According to information provided by ROGER BOUR (pers. comm.) it has been preserved in ethanol whereas all the other specimens mentioned above are preserved in formalin and methylated spirit, respectively.

All specimens collected by GRAHAM at Kunming are either males or juveniles. The marking of the Vienna specimen (NMW 29936.2) as a female is in error, probably based on the fact that its tail is truncated and there is damage to the supracaudals. This specimen furthermore shows manmade holes in each of the eleventh marginals. One such hole can also be found in the London type specimen, although in its case it was drilled into the tenth marginal on the left-hand side (Fig. 6). These holes account for a traditional

Fig. 1. Lateral view of the female type specimen of *Cuora yunnanensis* BMNH.1946.1.22.97, carapace length 138.5 mm. Photo: TORSTEN BLANCK.

Fig. 2. Dorsal and ventral views of the *Cuora yunnanensis* type series. From left to right: BMNH.1946.1.22.97, 1946.1.22.98, 1946.1.22.99, 1946.1.23.1 and 1946.1.23.2. Note the variability in coloration of both carapace and plastron as well as the differences in shell shapes. Photo: TORSTEN BLANCK.

Fig. 3. Lateral view of BMNH 1946.1.22.98, the largest known male *Cuora yunnanensis*; carapace length 125.5 mm. Note the low-domed carapace. Photo: TORSTEN BLANCK.

Fig. 4. Lateral view of NMW 29936.1 and 29936.2, an adult and a semiadult male. Photo: TORSTEN BLANCK.

Fig. 5. Frontal view of MNHN 1907.10. Note the distinct median keel on the carapace. Photo: ROGER BOUR.

Chinese practice of threading collected chelonians on a piece of string for easy transport (TANG pers. comm.). The same

Fig. 6. A device used to perforate the marginals of turtles as it is used in China until today. The resultant holes are obvious in BMNH 1946.1.22.97 and NMW 29936.2 shown below. Also note the truncated tail of NMW 29936.2. Photo: TORSTEN BLANCK.

holes are then also used for displaying the turtles at market stalls as well as preventing animals that are kept as pets from escaping. The holes are made with a specific tool of Chinese ingenuity (Fig. 6).

Considering that *Cuora yunnanensis* is a Chinese species, one should suppose that more specimens are to be found in Chinese museums. It is, however, extremely difficult to locate such specimens because many *Cuora amboinensis* and *Trachemys* sp. are erroneously labelled as *Cuora yunnanensis* in these collections. This has apparently also been the case at the Staatliches Museum für Naturkunde Schloss Rosenstein (SMNS) (ERNST pers. comm.) where it has meanwhile been corrected. In the Zoological Museum Hamburg (ZMH), in March 2005, the author reidentified without any doubt two specimens labelled *Cuora yunnanensis* (ZMH R00286 and R00287) as *Cuora amboinensis;* HALLERMANN adjusted the labels instantly. The same applies to Chinese zoos where *Cuora amboinensis* are commonly presented as *Cuora yunnanensis*, as is the case in Hong Kong Zoological Gardens. Managment of the latter were so convinced of really possessing the latter species that they even had it recorded under this name in the global databank ISIS (International Species Information System). The existing literature contains errors of the same kind. YANG & TANG (1998) figure *Cuora amboinensis* as *Cuora yunnanensis*, and FORNELINO (1992) *Cuora pani*.

A properly identified specimen exists in the Shanghai Natural History Museum (SNHM), now renamed Shanghai Science & Technology Museum (SSTM). Unfortunately, no contact could be established with this institution to find out its collection number. This specimen actually is the London specimen BMNH 1946.1.23.3 (for-

Fig. 7. The Beijing specimens IOZB 00167 (left), 00168 (top right) and 00169 (bottom right) in ventral and dorsal views. Photo: ZHOU TING.

	NMW 29936.1	NMW 29936.2	MNHN 1907.10	BMNH 1946.1.22.97	BMNH 1946.1.22.98	BMNH 1946.1.22.99
Locality	Yunnan Fu	Yunnan Fu	Yunnan Fu	Tungchuan Fu	Yunnan Fu	Yunnan Fu
Sex	♂	♂	♂	♀	♂	♂
Carapace (in mm)						
Length	99.7	87.5	107.2	138.5	125.5	102.2
Width	66.5	61.5	68.8	92.6	82.1	70.7
Height	34.7	31.2	38.0	55.6	41.8	34.4
W/L 1st vertebral	28.9/19.6	22.0/17.3	27.9/28.4	34.1/24.2	29.4/21.4	27.7/19.0
W/L 2nd vertebral	21.5/18.0	20.2/15.3	22.5/29.2	29.0/27.9	26.2/23.0	22.9/17.3
W/L 3rd vertebral	22.0/17.4	20.1/15.6	22.8/28.7	30.6/27.1	25.5/22.0	22.9/18.8
W/L 4th vertebral	24.3/14.7	23.8/16.0	25.5/28.0	33.4/25.9	29.3/22.8	26.8/17.8
W/L 5th vertebral	31.0/15.5	20.9/16.0	24.4/19.9	29.8/25.0	29.7/26.4	23.6/18.5
Plastron (in mm)						
Length	91.6	78.7	97.4	131.3	111.5	96.0
Width anterior seg.	43.0/42.0	38.1/34.7	46.0/49.1	65.3/55.5	51.8/48.5	46.8/42.6
Width posterior seg.	44.8/52.4	40.7/45.1	68.9/50.9	49.7/55.9	61.6/66.1	50.1/54.3
Bridge length	24.6	25.3	30.2	41.8	32.6	26.8
Gular width	12.0	9.0	12.5	12.5	11.0	10.7
Gular length	15.8	12.9	17.3	22.0	20.1	17.2
Humerals length	23.0	18.5	23.7	29.0	23.8	21.3
Humerals width	3.7	3.2	4.8	8.0	6.4	4.3
Pectorals width	24.0	19.7	25.0	30.0	27.7	25.0
Pectorals length	19.0	16.8	19.0	25.1	21.5	19.9
Abdominals width	27.0	22.0	28.5	35.0	30.8	26.8
Abdominals length	18.6	15.6	21.6	24.6	23.8	20.7
Femorals width	23.5	22.0	25.7	32.5	30.3	25.1
Femorals length	9.5	9.8	8.6	21.0	14.6	9.2
Anals width	18.5	15.0	19.8	23.5	20.9	18.4
Anals length	16.9	14.5	19.3	24.5	23.0	18.8
% Interanal suture	100.0	100.0	100.0	100.0	100.0	100.0
Axillars	R1 L1	R1 L1	R1 L2	R1 L1	1 Ax	1 Ax
Inguinals	R1 L1	R1 L1	R1 L2	R2 L1	1 Ing	1 Ing
Head and legs						
Front leg scale rows	12.0	13.0	12.0	11.0	11.0	9.0
Tail length	37.0	20.0	35.0	33.0	38.0	-
Head length	25.8	21.8	30.0	39.4	33.0	29.0
Head width	16.5	14.5	17.0	22.5	18.7	16.0
Eye diameter	7.0	6.0	7.0	9.0	7.0	7.0

Table 1: Measurements of all specimens of *Cuora yunnanensis* dealt with in the text, from ERNST, ZHOU & FU (pers. comm.) and own data.

merly BMNH 1906.5.29.6), which reached Shanghai in the framework of an exchange programme in 1987 (MCCARTHY pers. comm.).

A colour photograph of a *Cuora yunnanensis* that appeared to have been taken of a live animal was published in MENGWEN et al. (1998), and for a long time it was presumed that this would be proof for the species being still extant. As it turned out, however, the photograph was forged! In fact, it depicted the Shanghai specimen mentioned above whose eye had been pried open for the photoshoot. The specimen had then been placed on a meadow and photographed. A photograph that was made available to me by ZHOU TING clearly demonstrates this.

Three adult and very old specimens of *Cuora yunnanensis* are preserved in the

BMNH 1946.1.23.1	BMNH 1946.1.23.2	BMNH 1946.1.23.3	IOZB 00167	IOZB 00168	IOZB 00169	ZhangXi Nr.25	Lebend
Yunnan Fu ♂	Yunnan Fu Juv.	Yunnan Fu ♂	Kunming ♀	Kunming ♂	Kunming ♂	Xishan ♀	Kunming ♀
86.8	66.1	87.3	164.7	95.5	n/a	172.0	175.2
61.0	51.2	61.8	102.5	65.3	n/a	156.0	118.6
30.4	25.9	30.8	66.9	36.6	n/a	n/a	74.0
22.8/15.0	18.4/12.8	23.5/15.5	41.5/26.0	31.5/19.5	n/a	n/a	46.0/29.0
20.2/14.6	17.0/10.8	20.1/14.6	40.0/36.8	30.5/24.8	n/a	n/a	39.0/28.0
20.7/15.3	17.7/11.9	21.2/15.6	42/38.9	31.8/23.9	n/a	n/a	44.5/33.0
22.7/15.0	17.4/12.7	24.8/15.2	45.5/32.5	35.6/21.3	n/a	n/a	46.0/32.0
22.6/14.0	15.6/12.3	21.7/14.2	40.5/30.6	28.8/14.5	n/a	n/a	34.0/22.0
80.0	62.4	80.7	162.4	91.6	91.0	145.0	183.5
38.9/35.5	30.8/27.7	38.6/36.4	80.2/66.0	56.5/50.0	52.9/36.9	81.0	81.0/93.0
42.5/46.7	33.4/35.4	41.3/45.4	81.2/94.0	44.0/47.3	55.0/55.2	81.0	96.0/101.2
25.1	18.6	25.2	44.0	36.5	31.5	n/a	89.9
8.7	7.2	9.0	16.5	12.5	11.0	n/a	19.0
13.8	11.0	14.9	24.6	16.7	13.0	n/a	30.1
18.7	14.9	18.7	37.9	22.5	23.0	n/a	42.0
5.1	3.1	3.1	7.6	4.3	3.5	n/a	9.8
23.2	18.0	22.9	44.3	29.2	23.0	n/a	44.0
15.6	12.0	18.2	31.8	18.7	20.0	n/a	41.3
24.4	20.4	23.4	46.5	31.5	28.5	n/a	49.0
16.4	14.5	18.3	38.4	20.0	22.0	n/a	37.3
20.8	16.3	20.7	42.7	28.5	26.0	n/a	51.0
10.7	7.3	8.0	25.1	10.2	11.8	n/a	23.4
14.9	12.0	14.2	27.0	21.2	17.5	n/a	33.0
14.4	10.9	15.2	33.2	20.1	18.0	n/a	39.7
100.0	100.0	100.0	100.0	100.0	100.0	n/a	100.0
1 Ax	1 Ax	1 Ax	n/a	n/a	n/a	n/a	-
1 Ing	1 Ing	1 Ing	n/a	n/a	n/a	n/a	-
10.0	10.0	10.0	11.0	10.0	10.0	n/a	11.0
-	-	-	37.0	25.0	-	n/a	38.0
25.0	21.0	19.5	40.0	30.0	32.0	n/a	39.0
13.4	11.2	14.2	26.5	19.5	n/a	24.0	22.0
5.5	5.0	6.5	10.0	6.5	7.0	8.0	-

Animal Graduate School of China, better known as Institute of Zoology of the Chinese Academy of Sciences, Beijing (IOZB) (ZHOU TING pers. comm.). One of these is the adult female (IOZB 00167, formerly IOZB 397; Fig. 7) figured in ZHOU & ZHOU (1992), but it appears to have since slipped into total oblivion. A direct comparison of three specimens, i.e., the male IOZB 00168 (formerly IOZB 374), the above mentioned female (IOZB 00167) and a third specimen is provided here for the first time (Fig. 7). The third specimen was listed in the museum's catalogue, but unfortunately without its number. Nevertheless, ZHOU TING managed to locate it, and its number is IOZB 00169. It consists only of a head and neck, a plastron and a right front leg (Fig. 7). Judging from the shapes of the head and plastron, it is likely to have been a male. Following information obtained from the museum, the specimen had been used for a dissection (the operative removal of tissue). Interestingly,

nobody at the IOZB knew about the three specimens nor was it known that the species was extremely rare. The unfortunate result of this newly found awareness was that the IOZB subsequently refused to provide ZHOU TING with any more data (measurements, origin etc.). The institute furthermore laid claims on the copyright of his photographs so that they cannot be used for publication (ZHOU TING pers. comm.). On occasion of his visit, JAMES PARHAM (pers. comm.) was equally refused an examination of the specimens. Thanks to the assistance rendered by FU JINZHONG at least the measurements could be completed for Table 1.

The three Beijing specimens are adults with the female showing a few differences to the female syntype (lectotype) in London. Compared with the type series, the Beijing specimens differ in the following aspects: the carapace of the adult female virtually lacks all keels; the keels are minimally expressed (only the vertebral keel is recognizable) in the the male; the carapace is more curved towards its rear end; the reticulation of the gular region is less distinct, which may, however, be a result of their being preserved in alcohol (which in conjunction with warm storage also led to a reddening of the soft parts of the male). These are all traits that are absent in the specimens preserved in European museums. The localities of these three specimens are once more given as Kunming, but there are no dates of collection. According to an estimation by FU JINZHONG they have probably been secured in the early 1920'.

Interestingly, intense investigations by myself as well as ZHOU TING and STRAUSS (pers. comm.) suggest that the collection of the university at Kunming does not hold any specimens of this species, although one should suppose this to be the likeliest place to find them if the species indeed originated from Yunnan, respectively Kunming.

In April 1940, a professor of the name of ZHANG XI of the Peiping Academy of Sciences (ZHANG & CHENG 1946) collected an adult female specimen on the Xishan (25°02'N, 102°36'E; note: xi = west; shan = hill or mountain), some 19 km west of Kunming, which was marked with the field collection number 25. He later transferred to Qingdao (= Tsingdao) Ocean University of China, and this specimen is believed to have been lost in the war ravaging this region at the time (HOU MIAN & ZHOU TING pers. comm.). Following FU JINZHONG it would be entirely possible, though, that ZHANG XI, who worked for some time in Beijing, deposited this specimen in the collection of the University of Beijing, taking it along together with the entire collection of the former IOZB when he relocated to Taipei (Taiwan) during the Chinese Revolution in 1949. It is not, as ZHOU & ZHAO (2004) mentioned in error, the Paris specimen MNHN 1907-10. For one, it does not at all fit the size given by ZHANG & CHENG (1946). Secondly, it is a male. And thirdly, it had been in the Paris collection for some 35 years before ZHANG collected his specimen in May 1940.

So far it has been supposed that no further *Cuora yunnanensis* were found since BOULENGER's (1906) description (ERNST 1988, WANG & ZHAO 1998, ERNST 2000, IUCN 2000, MENG & SHI 2002, PARHAM et al. 2004). As this find suggests, however, the species did persist at least 34 years longer than has generally been believed! ZHANG & CHENG (1946) described the specimen collected in 1940 as having a straight-line length of 172 mm. IOZB 00167 is slightly smaller with 168 mm, and the type specimen is even smaller (138.5 mm). For detailed measurements see Table 1.

Most of the specimens dealt with here – six out of twelve plus the missing one of ZHANG XI's from 1940 – have nearly to completely escaped the attention of chelonologists until now. For example, the sizes and morphological traits of female

specimens were in dire need of detailed comparison. PARHAM et al. (2004) and ZHOU & ZHAO (2004) eventually published them on the basis of data obtained from the present author.

Based on the absence of finds of any live specimens, the IUCN Red List of 2000 listed the species as extinct since 1906. And until 2004 everything seemed to suggest that this species had indeed vanished from this planet forever. It served as a sad example for the Asiatic turtle crisis as it was the first of meanwhile

Fig. 8. A live female *Cuora yunnanensis* in lateral view, bought at a market in Kunming in May 2004. Photo: ZHAO HUI.

Fig. 9. Dorsal views of a female (BMNH 1946.1.22.97) and a male (BMNH 1946.1.22.98) in comparison. Note the differences in colour and shape of the carapace. Photo: TORSTEN BLANCK.

Fig. 10. Lateral view of a juvenile *Cuora yunnanensis* (BMNH 1946.1.23.4), carapace length 66 mm; the distinct dorsolateral keels are of particular interest. Photo: TORSTEN BLANCK.

numerous highly endangered species that seemingly had become extinct.

A live specimen?

It came almost as a shock when, in the summer of 2004, a Chinese gentleman sent the present author photographs of an unidentified turtle. In spite of the poor quality of the photographs and a few differences (see farther below) the depicted turtle could be readily identified as a live (!), adult, female *Cuora yunnanensis*. The photographs had been taken shortly after the turtle had been purchased at a food market in Kunming, i.e., the „Jing Xing Bird & Flower Market". Originally it was claimed that the animal had been acquired in 1997, and everything seemed to suggest that it had found its end in a cooking-pot. Soon thereafter it turned out, though, that the animal was purchased as recently as in May 2004 and it was still being kept by its owner (ZHOU TING pers. comm.).

Unfortunately, the photographs were also published in a Chinese Internet forum for chelonians where they stirred up a genuine „*yunnanensis* mania" amongst many Chinese and Japanese enthusiasts who flooded the owner with offers to purchase the animal at partly astronomical prices. ZHOU TING was able to visit the owner and take measurements and photographs of the specimen (Tab. 1, Fig. 8). ZHAO & ZHOU (2004) also presented the animal, but compared it only with the sparse information contained in the original description by BOULENGER (1906) and not directly with the type series. It differs from the type specimens as to its morphology and particularly with regard to its coloration, as will be demonstrated in the following chapter.

Morphological traits of males and females

The relatively flat carapace is of an elongated oval shape in male specimens. It shows a distinct widening in its posterior half that increases with age. Juveniles are therefore more rounded in their outline than adults (Fig. 2).

Compared to males, female specimens have a distinctly higher carapace with a different ratio of carapace height to length. It is clearly more steeply formed laterally and shows an elongated oval outline. It does not widen in the posterior half, i.e., it maintains a very constant width throughout its length.

In juvenile, semiadult and young adult specimens the carapace shows a distinct central keel that is flanked by a slightly less distinct keel on either side (Fig. 10). These keels, and in particular the two outer ones, disappear as a specimen ages and more so in females. Old females, such as IOZB 00167 and the live specimen, do not show any of these keels anymore, and in old males (e.g., BMNH 1946.1.22.98) they may be reduced to mere indications (Figs. 8 and 9).

The posterior marginals are slightly serrated in juveniles, but smooth in adults. The seventh and eighth marginals are larger than all the others. The supracaudal is divided and sports a shallow notch. The second through fourth vertebrals are as long as they are wide and fairly constant as to their hexagonal shapes. In adult specimens they are straight and smaller than the costals. Growth rings are clearly visible in juvenile, semiadult and young adult specimens, but not in very old ones.

The basic coloration of the carapace varies in the thirteen specimens examined from dark brown through hazel to a pale shade of olive brown. The latter applies to the Beijing specimens IOZB 00167, 00168 and 00169 as well as to the Paris one (MNHN 1907-10), but this is probably a result of their type of preservation that may have brought about a fading of the original colours. The hazel and dark brown colours, on the other hand, must be regarded as representing a certain degree of variability within the species as the respective specimens have been preserved in the same jar for equal periods of time. This is

the case in NMW 29936.1 (dark brown) and NMW 29936.2 (hazel) or BMNH 1946.1.22.98 (dark brown), 1946.1.22.99 (hazel), 1946.1.23.1 (hazel), 1946.1.23.2 (hazel) and 1946.1.23.3 (hazel). The separately stored specimen BMNH 1946.1.22.97 is also hazelnut-brown. The live animal is reddish brown in colour (Fig. 11).

The nuchal is distinct and quadrangular to trapezoid in shape. The median keel is always lighter in colour than the remainder of the carapace and becomes even lighter as a specimen ages. This trait is recognizable even in specimens that have only a minimum of a median keel left or none at all.

The plastron is usually shorter than the carapace, but longer in the live female (comp. Tab. 1). In all specimens, except NMW 29936.1 and the live female, the plastron is uniform honey-coloured and not, as was stated by ROGNER (1995), dark brown. Most specimens have reddish deposits on their plastral scutes, though, the colour of which is created by iron oxide. It is also fairly common in freshly imported turtles of other species. The extent of these deposits varies greatly. While it is minimal in NMW 29936.1, it covers more than 90 % of the plastron in BMNH 1946.1.22.99. An analysis of these deposits could possibly reveal information on the habitat of the species. In contrast to all other specimens, NMW 29936.1 exhibits an obscure brownish pattern on its plastron that resembles the black barred pattern of *Cuora pani* (comp. Fig. 12). The live female has on its plastron a central blackish spot that extends beyond the centres of the pectorals, abdominals and femorals (Fig. 13). The sutures of the plastron are more or less black in all preserved specimens, jet black in the live female. The bridge is dark only in NMW 29936.1 and the live female. The lower sides of the marginals are pure honey-coloured in all specimens, again with the exception of NMW 29936.1.

Both BOULENGER (1906) and POPE (1931) described the hinges as weakly developed in comparison with other species of *Cuora.* The posterior plastral segment in particular was said to not achieve full closure. Up to a carapace length of 85 mm the plastral segments are entirely immobile, as is the case in morphologically similar species of *Cuora* (*Cuora pani*, *C. aurocapitata* and *C. trifasciata*) (pers. obs.).

Comparisons of the individual museum specimens with preserved *Cuora trifasciata* and *C. aurocapitata* did not reveal differences as to their mobility, however. The plastral segments of the latter were hardly mobile or not mobile at all, although they can be fully closed by live specimens. SIEBENROCK presumed as early as in 1909 that adult specimens were able to close their plastra fully. The live female can indeed close her plastron fully although her state of nutrition will probably prevent a full closure.

The anal scutes of all adult and semiadult males (NMW 29936.1 and NMW 29936.2, BMNH 1946.1.22.98, 1946.1.22.99, 1946.1.23.01 and 1946.1.23.02, MNHN 1907.10 as well as IOZB 00168 and 00169) and the juvenile specimen BMNH 1946.1.23.03 are distinctly notched posteriorly. A distinct notch is also present in BMNH 1946.1.22.97, which is a young adult female. This contrasts clearly with IOZB 00167 and the live specimen which both are adult females, too, but evidently older than BMNH 1946.1.22.97. There, the notches are reduced to mere indications (comp. Fig. 13), which corresponds, for example, with the situation encountered on occasion in old *Cuora aurocapitata* females (pers. obs.). Compared with specimen BMNH 1946.1.22.97, which is only about 30 mm smaller, and in relation to the lengths of their plastra, their tails are substantially shorter. Figure 13 depicts the animals in a direct comparison. The latter also makes obvious that they differ as to the shapes of their carapaces. The carapace

Fig. 11. Live *Cuora yunnanensis*; note the coloration of the carapace. Photo: ZHOU TING.

Fig. 14. Lateral view of the head of the live *Cuora yunnanensis*. Note the interesting yellow spot at the dorsal base of the head. Photo: ZHOU TING.

of IOZB 00169 is distinctly more pointed at its posterior end than that of BMNH 1946.1.22.97. The live female has a carapace shape intermediate to these two specimens.

Plastral formulae of the individual specimens are as follows: IOZB 00167 and 00169, BMNH 1946.1.22.99, 1946.1.23.01 and 1946.1.23.02 as well as NMW 29936.1 and MNHN 1907.10: Abd. > Pect. > An. > Gul. > Fem. > Hum.;

Fig. 12. Plastral views of *Cuora yunnanensis* and *Cuora pani*, NMW 29936.1 on the left, right SIZ 80170, in comparison. Photos: TORSTEN BLANCK & SONG MING-TAO.

Fig. 13. Comparison of carapaces and plastra of female *Cuora yunnanensis* and *Cuora pani*. From left to right: IOZB 00167, BMNH 1946.1.22.97, live *Cuora yunnanensis*, live *Cuora pani*. Photos: ZHOU TING, TORSTEN BLANCK, ZHAO HUI & TANG MICHAEL.

Fig. 15. Comparison of the cephalic traits discussed in the text of *Cuora yunnanensis*. Left column: BMNH 1946.1.22.97 (top), IOZB 00167 (centre) and NMW 29936.1 (bottom); central column: live (top), BMNH 1946.1.22.98 (centre) and BMNH 1946.1.23.2 (bottom); right column: *Cuora pani* (top), *Chinemys reevesii* (centre) and *Cuora flavomarginata* (bottom) from Sichuan. Photos: TORSTEN BLANCK, ZHOU TING & TANG MICHAEL.

IOZB 00168, BMNH 1946.1.22.98 and the live specimen: Abd. > An. > Pect. > Gul. > Fem. > Hum.;

NMW 29936.2: Abd. = Pect. > An. > Gul. > Fem. > Hum.;

BMNH 1946.1.22.97: Abd. = Pect. > An. > Fem. > Gul. > Hum.;

Interestingly enough, ZHANG XI quoted for his specimen No. 25: Abd. > Hum. > An. > Pect. > Fem. > Gul.

Fig. 16. Comparison of gular patterns of *Cuora yunnanensis*. Note the consistency of the markings in all but the live specimen. First row: BMNH 1946.1.22.97, 1946.1.22.98, 1946.1.22.99, 1946.1.23.1 and 1946.1.23.2; second row: IOZB 00167 and 00168, NMW 29936.1 and 29936.2 as well as MNHN 1907.10. Photos: TORSTEN BLANCK, ZHOU TING & ROGER BOUR.

The dark olive brown head of *Cuora yunnanensis* is elongated and appears relatively narrow and pointed (similar to *Cuora pani)*. The upper jaw projects slightly over the lower one, but its tip is not cuspid (undivided). Following BOULENGER (1906), SMITH (1931), POPE (1935) and ERNST (1988), the sides of the head each sport two yellowish stripes with dark borders.

Fig. 17. Gular coloration of the live *Cuora yunnanensis*. Note the distinct differences in the pattern as compared with the specimens shown in Fig. 16. Photo: ZHOU TING.

The upper lateral stripe runs at about eye-level, the lower one follows the upper jawline. These stripes vary with the individual specimens, and in some there are additional lines. In general, however, the upper stripe is a constant trait. It begins at the nostril, bypasses the eye above where it diminishes in intensity, and finally continues above the ear-opening onto the neck. NMW 29936.2, BMNH 1946.1.22.98, 1946.1.23.01 and MNHN 1907.10 all have a narrow short streak immediately below the (main) stripe right behind the eye. Only a fine brownish line that ends short of the tympanum separates the two markings. Such a streak is absent in NMW 29936.1, BMNH 1946.1.22.97, 1946.1.22.99, 1946.1.23.02, 1946.1.23.03 as well as IOZB 00167, 00168 and 00169 (Fig. 15). The live female once more represents an exception in this regard: while it also has such a streak, it is clearly separated from the main stripe and extends from the eye to a short distance behind the tympanum (Fig. 15).

The lower stripe is usually thinner than the upper one and often discontinuous. It starts off like the upper stripe (not so in the live specimen), follows the lipline along the upper jaw with an arch below the eye, and, passing the tympanum below, extends onto the neck. In NMW 29936.1 and BMNH 1946.1.22.97 the lower stripe is broken in places and reaches only as far as the tympanum. NMW 29936.2, BMNH 1946.1.22.99, 1946.1.23.01, 1946.1.23.02, 1946.1.23.03, MNHN 1907.10 as well as IOZB 00168, 00169 and the live specimen all have a distinctly developed lower stripe that is nearly to entirely continuous. In the live female, the stripe is completely separated and forms a maxillary stripe similar to the one found in *Cuora amboinensis.* In IOZB 00167, on the other hand, the stripe is also continuous and well developed, but forks off an upward branch at the level of the tympanum. This branch bypasses the tympanum and ends behind it (Fig. 15). BMNH 1946.1.22.98 has a well-developed lower stripe that extends continuously to the neck, but it has an additional stripe below it. This one ranges from the angle of the jaws to the tympanum.

The live specimen has a dorsolateral yellow spot on either side of the head. Markings of this kind are absent in all other specimens.

The eyelids are whitish yellow, and the upper jaw is whitish yellow olive in colour. The yellowish gular region shows a pattern of brown spots (Fig. 16). This spotted pattern is highly constant in all museum specimens. It consists of a central cone-shaped marking that begins right behind the tip of the lower jaw and widens substantially towards the lower end of the throat. Two dots or spots are situated on either side of this cone. Again, the live *Cuora yunnanensis* represents an exception in this aspect (Fig. 18), raising the question of whether it is an expression of individual variation (that is minimally present in all the other specimens) or of geographical diversity. The latter appears unlikely if one takes into consideration that the other specimen are very much alike otherwise although they were collected at different locations.

Like McCord & Joseph-Ouni (2002) the present author presumed that the pupil would have a distinct black bar across (Fig. 15), as is the case, for example, in *Chinemys reevesii.* In order to verify this detail, the eyes of some museum specimens were carefully pried open, and in BMNH 1946.1.23.3 a very faint indication of such a stripe could indeed be supposed. The indistinct expression of this trait is most certainly a result of the preservation process that is sure to cause some fading. The live specimen displays this trait clearly.

Following Boulenger (1906), the lateral lines on the head, the stripes on the legs and the gular spots are orange in colour. According to Smith (1931) they are yellow and orange in live specimens. Pope (1935), Rogner (1995) and Schilde

(2004) stated that the gular pattern of live specimens consisted of orange and yellow spots. The live female as well as all museum specimens have a pale yellow gular coloration, and the stripes are of the same colour. As to the gular pattern, it is actually formed by the brown markings (Fig. 15).

The front legs end with five pointed, strong, curved claws, whereas there are only four on the hindfeet. The legs are dark brown in colour. The feet are webbed, which suggests an aquatic biology for this species. The outer sides of both the front and hind legs are each marked with a yellowish stripe. Furthermore, the front legs and feet each carry a bold yellowish stripe that extends from the base of the leg to the second claw (Fig. 18). Such a stripe is also present in *Mauremys rivulata*, but there it runs to the first claw! BMNH 1946.1.22.98 exhibits a second stripe on the front sides of the front legs. It forks off the main stripe and extends to the first claw. The live specimen has a small yellow spot at the base of each claw on all front and hind feet (Fig. 18).

The inner sides of the legs sport yellowish reticulations and so do the soft parts. Both traits are again found in *Mauremys rivulata*. The tail is dark brown and marked with two light dorsal stripes (as is the case in *Cuora pani* and *Cuora trifasciata*, for example). It is fairly long, but as was mentioned earlier, distinctly shorter in relation to the plastron length in the female IOZB 00167 and the live specimen than in BMNH 1946.1.22.97.

Sexual dimorphism

The tail is thicker at its base in male specimens, and the cloaca is situated behind the margin of the carapace. Furthermore, the tail is distinctly longer in relation to the length of the plastron in males than it is in females. The plastron may be slightly concave in male *Cuora yunnanensis*, as is the case in BMNH 1946.1.22.98. The carapace of adult males is widest between the eighth and ninth marginals. The lateral posterior marginals are slightly raised. As was mentioned above, the carapace of a female is distinctly more arched than that of a male. It is elongated oval in its outline and does not widen in its posterior half, i.e., its width remains very constant throughout its length. The heads of males appear clearly narrower and more petite than those of females. The anal notch is only weakly expressed in old females, but remains distinct in adult males. In general the sex-dependent differences are very similar to those found in *Cuora pani* and *C. aurocapitata.*

The largest male measured so far has a straight-line carapace length of 125.5 mm (BMNH 1946.1.22.98); the largest female known (live) measures 175.2 mm. The latter measurement constitutes a new maximum size record that substantially exceeds the estimates of a maximum carapace length of 140 mm of previous authors (BOULENGER 1906, SIEBENROCK 1909, SMITH 1931, POPE 1935, ERNST 1988, SCHILDE 2004 and others). Their appraisals were clearly based on the 138.5 mm-specimen BMNH 1946.1.22.97, which was considered the largest *Cuora yunnanensis* until the Beijing specimen IOZB 00167 and the live animal were discovered.

As has been demonstrated above, the live specimen differs in some aspects from the museum material, which is particularly true for its coloration. Its morphological traits, however, suggest beyond doubt its identity as *Cuora yunnanensis* as does the general structure of its colour pattern. Based on the differences in coloration the present author presumes that this specimen may originate from a different population than all the other known specimens. The appearance of a live animal furthermore proves that the species has managed to survive to the present day, but also raises the two questions of How and Where.

Fig. 18. Colour patterns of the legs of *Cuora yunnanensis*. Upper row: live specimen front leg, hind leg outer side, hind leg inner side; lower row: front leg of BMNH 1946.1.22.98 (with the double stripe mentioned in the text), NMW 29936.2 hind leg, outer and inner sides. Photos: ZHAO HUI & TORSTEN BLANCK.

The hybrid theory and genetics

As is common knowledge today, the Chinese are extraordinarily skilled when it comes to crossbreeding various species, and they can even take this beyond generic boundaries. By now more than one-hundred turtle hybrids have become known from Southeast Asia alone (BLANCK & SCHAFFER in prep.). It is also known (ZHOU TING pers. comm.) that Chinese have been keeping and propagating turtles for some 3,000 years. This is demonstrated by the find of extremely old hybrid specimens (BLANCK & SCHAFFER in prep.).

Based on these facts, various chelonologists who took a closer interest in *Cuora yunnanensis* did not exclude the possibility of a hybridogenic origin of this turtle (BARZYK pers. comm., ERNST pers. comm., IVERSON pers. comm., MCCORD pers. comm.). Potential parent species included the morphologically very similar species *Cuora pani* and the similarly coloured *Chinemys reevesii* (BARZYK pers. comm., ERNST pers. comm., IVERSON pers. comm., MCCORD pers. comm.). *Chinemys reevesii* is an obvious choice because of the presence of three clearly defined keels on its carapace that are particularly distinct in juvenile specimens. This is also the case in *Cuora yunnanensis*. *Chinemys reevesii* furthermore shows a distinct reticulated pattern on the chin and an assortment of stripes on the sides of the head. Sichuan specimens, for example, have only two head stripes (Fig. 15). Clearly identified hybrids that involve *Chinemys reevesii* are known to have reticulated chins in almost all instances (BLANCK & SCHAFFER in prep.).

The verification of this theory necessitates DNA analyses. It is, however, a very difficult undertaking, considering that all specimens of *Cuora yunnanensis* known so far, except the unique live specimen, have been stored in formalin, ethanol and methylated spirit, respectively, for some 100 years.

Following COLLIN MCCARTHY (pers. comm.), the curator of herpetology at the BMNH, the London specimens were probably first fixed in formalin and later preserved in 80 % methylated spirit. The methylated alcohol contained therein destroys DNA completely. JAMES PARHAM (pers. comm.) commented on this subject that the DNA of formalin-preserved specimens would be denaturalized, which renders sequencing much more difficult. Nuclear markers would be required, but the development of respective technology has as yet not advanced very far. Only the specimen preserved in Paris (MNHN 1907-10), an adult male, has been preserved in ethanol, according to information received from the curator at the MNHN, ROGER BOUR. It is the only preservative that does not destroy DNA and therefore, sequencing remains a possible option. It must be mentioned, though, that this specimen, like the others collected by GRAHAM, was originally fixed in formalin. Thus, it had been exposed to formalin from the time it was originally collected in Kunming until it eventually reached London. It was only later, and probably much later, that the specimen was rebottled.

I conveyed this information to JAMES PARHAM and suggested that the Paris specimen be sequenced, as it would hold the greatest promise. I also suggested that all

other specimens, and the Beijing ones in particular, be sequenced.

The results of the studies that followed and of the sequencing of the Paris specimen were subsequently published by PARHAM et al. (2004). According to these, the possibility of a hybridogenic origin of *Cuora yunnanensis* is remote; it is a clearly distinguishable species. The data obtained suggest it to be a sister taxon of *Cuora flavomarginata*, a highly terrestrial species that shows little morphological similarity to *Cuora yunnanensis*. The morphologically very similar species, *Cuora pani*, *C. aurocapitata* and *C. trifasciata*, on the other hand, appear to be quite far removed genetically from *Cuora yunnanensis* (PARHAM et al. 2004).

Personally, I have doubts as to this interpretation because the morphological aspects clearly suggest a close cladistic relationship with the *Cuora pani-aurocapitata-trifasciata* group (see below). Such a relationship was also suggested by SMITH (1931), POPE (1935), PRITCHARD (1979), SONG (1984), ERNST & MCCORD (1987), ERNST (1988), ERNST & BARBOUR (1989), XIANGKUI (1999) and FENG et al. (2004). The morphological analyses of MCCORD & IVERSON (1991) support a position of *Cuora yunnanensis* within this group and show that it is readily distinguished morphologically from *Cuora flavomarginata*. Based on the studies by ERNST (1988) and MCCORD & IVERSON (1991), YASUKAWA et al. (2001) equally supposed a close relationship of *Cuora yunnanensis* with the *C. pani-aurocapitata-trifasciata* group, although these authors failed to examine any *Cuora yunnanensis* themselves.

From a morphological viewpoint, *Cuora pani* can be distinguished from *Cuora yunnanensis* only on the basis of its coloration, the comparatively slightly longer interfemoral suture of *Cuora yunnanensis* (ratio 1 : 1.2; comp. MCCORD & IVERSON 1991), and the more weakly expressed carapace keels in adult *Cuora pani* (comp. SONG 1984). Furthermore, the posterior plastral notch is a little more distinct in old female *Cuora pani* than it is in *Cuora yunnanensis*.

Likewise, morphological differences between *Cuora aurocapitata* and *Cuora yunnanensis* are limited to the slightly longer interfemoral suture (comp. MCCORD & IVERSON 1991) and the more weakly expressed carapace keels of adult specimens. The plastral notch is relatively identical in its weak expression in old females, and its stronger manifestation in juveniles and young adults of both species.

Cuora trifasciata differs morphologically from *Cuora yunnanensis* in its colour pattern, a slightly longer interfemoral suture (ratio 1 : 1.1), and, like *Cuora pani*, in the more weakly expressed notch splitting the anal scutes (comp. Figs. 12 and 13).

Fig. 19. Frontal view of the live *Cuora yunnanensis*. Photo: ZHOU TING.

Cuora yunnanensis differs from *Cuora flavomarginata* in its colour pattern, the less distinctly arched carapace with its clearly distinguishable shape and arrangement of scutes, and the usually well-defined notch separating the anal scutes (with the exception of IOZB 00167 and the live specimen that both have weakly expressed notches due to their ages). *Cuora flavomarginata* has no such notch, with the anal scutes meeting to form a rounded edge. The interfemoral suture of *Cuora yunnanensis* is longer (ratio 1 : 2). The overall habitus does not all resemble that of *Cuora flavomarginata*. A more detailed morphological comparison is in preparation (BLANCK in prep.).

Another fact that casts some doubt on the results obtained by PARHAM et al. (2004) is the fact that samples of only one specimen were examined, i.e., the Paris specimen that has been lying in ethanol for some one-hundred years after it had, like the specimens of the type series, originally been fixed in formalin. As was mentioned above, I had recommended that all known specimens of *Cuora yunnanensis* be included in the study. Sequencing and osteological studies of the remaining museum specimens, and in particular those in the collection of the IOZB and the live animal, are urgently needed to shed light on the taxonomic status of *Cuora yunnanensis.*

Origin

Like in the case of several other species of Asiatic turtles there is no recent record of *Cuora yunnanensis* from the wild. This leaves the geographical distribution of the species to speculation. So far, three localities have been supposed for *Cuora yunnanensis*: firstly, Dongchuan (26°11‘N, 103°03‘E), which is the type locality of BMNH 1946.1.22.97, in the north of the Chinese province of Yunnan, secondly, Kunming (25°02’N, 102°43’E), which is the capital of Yunnan Province and the locality of all other museum specimens as well as the live animal, and thirdly, Xishan (25°02’N, 102°36’E), which was given as the collection locality by ZHANG XI and is a national park near Kunming today. These three localities are shown in Map 1 and will be discussed now.

From a climatic viewpoint the province of Yunnan is marked by “infinite spring”. During winter (November through February), the average temperature is 10 °C (minimum -5,4 °C) in Kunming, reaching close to 20 °C in summer (with an extremely rare maximum of 33 °C; during the past twenty years maxima did not exceed 23 °C according to www.wetteronline.de). The annual average temperature ranges between 14,5 and 15,7 °C (these values differ between MÜHR [2000] and MÜLLER [1996]). A rainy season marks the time from May to October. The annual amount of precipitation ranges from 1008 to 1096 mm (MÜHR 2000, MÜLLER 1996). Following MÜLLER (l.c.) there are 2172 hours of sunshine and 230 days without frost per year. The highest summit of Yunnan is Mazong Peak in the Jiazi Mountains that rises to 4,274 m above sea level. The lowest points lie at 695 m a.s.l. in the valleys of the Xiaojiang and Jinsha Rivers near Dongchuan.

Cuora yunnanensis is presumed to inhabit mountain streams and rivers, quite in the fashion of the very similar *Cuora pani.* The latter has recently been found in the wild (BLANCK & TANG in prep.).

ZHANG XI & CHENG (1946) categorized the seasons in the Kunming region as follows: (1) January/February: period of hibernation with most reptiles remaining hidden and making it difficult to find them. (2) March/April: the weather turns warmer, and most reptiles are fairly active (author’s annotation: it was at this time that ZHANG XI collected the *Cuora yunnanensis* mentioned in ZHANG XI & CHENG [1946]). (3) May through October: rainy season in Kunming, lush growth of plants, abundance of food, relatively warm climate; this is the time when most reptiles are found. (4) November/December: the

weather becomes cooler, most reptiles retreat to their winter shelters.

Although thirteen of the fourteen known *Cuora yunnanensis* are said to originate from Kunming it remains questionable whether this species actually ever occurred there. This is for the following reasons: Kunming (25°02'N, 102°43'E) lies at 1893 m a.s.l. on the northern end of the 39 km-long Lake Dianchi (Fig. 21). Stretching over 340 km² this is the six-largest and at the same time with an average depth of 4 m the shallowest lake in China. The above mentioned climatic conditions of this plateau appear relatively poorly suited to support turtle life. This is also demonstrated by the absence of any other species of turtle in this region. Not even *Chinemys reevesii*, which is otherwise found nearly everywhere in China, lives in this area (IVERSON [1992] illustrated a specimen found at a food market; XIE et al. 2001)!

If the species really ever occurred here, it would have to be regarded as more adaptable than both *Emys orbicularis* (European pond turtle) and *Chelydra serpentina* (common snapping turtle) as to its tolerance of temperature and altitude. *Emys orbicularis* does of course occur, for example, in Germany where it is slightly colder by comparison, but is confined there to optimum habitats that still facilitate its reproduction (FRITZ 2001). This necessitates a low altitude with a high degree of exposure to sunlight, a large number of sunny days per year, and day temperatures of distinctly above 20 °C during the summer months. Likewise, *Chelydra serpentina* ranges up into southern Canada (IVERSON 1992), but requires for successful incubation of its eggs at least temporarily elevated temperatures in summer, more days of sunshine, and a distinctly lower amount of precipitation than the conditions at Kunming would provide.

The summer in Kunming is marked by temperatures that hardly climb above 20 °C during the day, and, in contrast to the conditions encountered in Germany or Canada, this period coincides with the rainy season. Eighty-five percent of the annual amount of precipitation are received during this period. The hours of sunshine during the height of summer are as a result reduced to less than 100 (MÜLLER 1996) as compared to more than 200 hours in Germany and southern Canada. These are circumstances that would clearly hamper a successful incubation of turtle eggs. Finally, no other species of *Cuora* is known to have adapted to so cool a climate.

Lake Dianchi itself is an unlikely habitat for *Cuora yunnanensis* as the turtle exhibits the morphological adaptations of a river- or creek-dweller, marked by a relatively low, streamlined carapace similar to that of *Cuora pani.* If the species used to occur there against all expectations, its disappearance could be explained by the extreme degree of pollution of the lake (comp. www.usembassy-china.org.cn/sandt/dianchi.htm), the destruction and urbanization of possible oviposition sites, and possibly also the pressures caused by the introduction of predators (see below).

The economic rise of Kunming that started in the 1940' brought about an ever-increasing pollution of Lake Dianchi with heavy metals and industrial wastes. Purification of some of the wastewater began only a few years ago. The lake has to cope with an annual charge of 500 tons of phosphates, 5000 tons of nitrates and 200 million tons of other liquid wastes that in part contain high concentrations of extremely toxic substances! Meanwhile the excessive load of nitrates and phosphates cause the lake to be covered for about 85 % by dense layers of algae during the summer months (EMBASSY BEIJING 2000). Taking into consideration the extent of industrial, respectively chemical, pollution, the draining of wetlands, clearing of forests, and the mining of ore that have been taking place in this area for more than 300 years, the disappearance of vari-

Map 1. 1-3 = Recorded "localities" of *Cuora yunnanensis* (see text), 4 & 5 = "localities" of *Cuora zhoui* according to McCord & Iverson (1991). Green area = presumed distribution range of *Cuora yunnanensis*, red area = previously presumed distribution range which, according to the information provided by Tang (pers. comm.), now appears rather unlikely.

ous species of animal life would be plausible.

One such example could be the newt, *Cynops wolterstorffi* (Boulenger, 1905), that has not been found again in Yunnan after 1986 although it used to be very common in the wetlands around Kunming and in Lake Dianchi until 1950 (Zhao 1998). The wetlands do largely not continue to exist in their original form today and are, as was mentioned above, badly polluted or populated with introduced predators such as ducks (there is a flourishing industry of waterfowl at Lake Dianchi) and grass carp. These are believed by Zhao (1998) and IUCN (2000) to have played a major role in the disappearance of *Cynops wolterstorffi*. They presume that the ecology of the lake has been changed dramatically, which would also explain why aquatic plants that used to occur there originally have effectively been eradicated. The extent of anthropogenic interference has rendered the affected zones uninhabitable for amphibians and reptiles.

Not a single specimen of *Cuora yunnanensis* can be found in local museum collections (e.g., that of the University of Kunming) whereas all other species of turtles native to Yunnan and neighbouring provinces are represented in quite remarkable numbers (Strauss pers. comm.)! Based on the climatic conditions around Kunming it must be supposed that *Cuora yunnanensis* has probably never occurred there or at least does not occur there anymore. The other factors rather support the notion that the species - should it have occurred there in spite of all expectations - meanwhile has no longer any chances of survival there.

The following scenarios could provide possible explanations how specimens of *Cuora yunnanensis* ended up in Kunming:

1) Kunming is situated at the southern Silk Route so that the animals could have reached this region by means of trade-related activities from the south, i.e., from Laos, Viet Nam or Thailand. This is rather unlikely, however, as *Cuora yunnanensis* is morphologically similar to *Cuora pani* and *C. aurocapitata* which both inhabit tributaries of the Yangtze River. This similarity suggests that these species were in more or less close contact at one time (Blanck & Tang in prep.). Following Parham et al. (2004), *Cuora yunnanensis* is supposed to be genetically more closely related to *Cuora flavomarginata*. This species also occurs in the catchment areas of the Yangtze and Fuchan Rivers (Fong et al. 2002), including the northern parts of Sichuan Province. Still, Laos and Viet Nam are separated from the headwaters of the Yangtze and the distribution ranges of *Cuora pani*, *C. aurocapitata* and *C. flavomarginata* by several hundred kilometres. These disjunct regions were also

not connected via rivers systems during prehistoric times so that an occurrence of *C. yunnanensis* there is rendered rather doubtful.

To the north the southern Silk Route traverses the Yangtze delta, crosses through Sichuan to reach Xian, the capital of Shaanxi Province. From there, the main route continues towards Tibet. This would create a link to the distribution range of the morphologically very similar *Cuora pani* and render a northern point of origin a possibility. Like *Chinemys reevesii, Cuora pani* occurs in the provinces of Shaanxi and Sichuan.

2) Several rivers drain into Lake Dianchi, amongst which are the Bao-xiang and the very short Kunming River that crosses through Kunming City. This gives rise to the idea that *Cuora yunnanensis* may from time to time be swept into Lake Dianchi, where it is caught and brought to the food markets of Kunming. But again, it is unlikely. All these rivers have their sources at higher altitudes than Kunming itself so that the ecological requirements of the turtle would be even more compromised.

Although Lake Dianchi has several tributaries, it has only one outlet in the form of the Tanglang River. This drain is situated at the southwestern end of the lake at Haikou and, after joining the Pudu River, empties into the Jinsha (Yangtze). Because it is also connected to the Yangtze-kiang, this river would be a good place to look for turtles if it were not for its being as polluted as the lake which it drains.

3) ZHANG XI collected his specimen in May 1940 on the Xishan (ZHANG & CHENG 1946) (25°02'N, 102°36'E), which translates as West Mountain. This is now a national park situated about 19 km west of Kunming. It also borders Lake Dianchi and is today surrounded by tobacco plantations. ZHANG unfortunately failed to provide more detailed information as to where exactly the animal was found, e.g., in the lake, in a river, creek or pond. As the lake is an improbable habitat (see above) and there are no rivers on the Xishan, only creeks and ponds remain as possibilities. Ponds do indeed exist here, that is in the form of ornamental pools at Buddhist temples! These are known to be used for keeping turtles that pilgrims may bring from afar. Kunming is not only an important centre of trade, but also a multicultural city where various religions are represented and these include Buddhism. The oldest and at the same time most important

Fig. 20. Xiao-jiang near Dongchuan, a possible former habitat of *Cuora yunnanensis*? Photo: TANG MICHAEL.

Fig. 21. Jinsha-jiang at the boundary between Yunnan and Sichuan. Could *Cuora yunnanensis* possibly originate from here? Photo: TANG MICHAEL.

Buddhist holy place of Yunnan Province is the 1,200 year-old temple of Yuantong Si. It is situated in the northern part of Kunming. The temple grounds include a large pond in which numerous turtles are kept even to this day (today mainly *Trachemys scripta* ssp.). The temple of Yuantong Si was, and still is, an important destination for pilgrims from all over the world. Would it be possible that *Cuora yunnanensis* came to Kunming in the baggage of some pilgrims? Could Father GRAHAM have found his specimens on occasion of a visit to the temple?

If the turtles had laid eggs in the temple grounds, their incubation could have been possible in an above-average summer. The temperatures would then have been on the lower limit of tolerance, but this would actually explain why all the specimens said to originate from Kunming are males!

GRAHAM is much more likely to have found his specimens on a food market, though, maybe even on the famous Kunming Jing Xing Bird & Flower Market. This is the same place where the live female was discovered recently. The market has been in existence for more than a hundred years (ZHOU TING pers. comm.). HAITAO (2002) was unable to locate any *Cuora yunnanensis* when he visited Kunming markets. Others who also tested their luck here did neither find this evasive turtle nor did market traders know of such a turtle (HOU MIAN pers. comm., STRAUSS pers. comm., TANG pers. comm., ZHOU TING pers. comm.).

The notion that GRAHAM obtained his specimens at a market is supported by the presence of manmade holes in the marginals of two specimens. These are clear indications of their having been handled by local people before! How else would it have been possible to collect not less than eight *Cuora yunnanensis* which must have been very rare even back then? As was mentioned before, there is not a single individual present in any scientific collection throughout Yunnan. Local people also do not appear to know this species (STRAUSS pers. comm.).

It is more than curious that in 1905/1906 GRAHAM managed to collect eight *Cuora yunnanensis* in Kunming in one sweep, including the three Beijing specimens, and that in then took until 1940 before the next one was found by ZHANG XI in the Xishan area. Then, another 64 years had to pass before another one surfaced in Kunming. There appear to be no records of this species from either before 1905 or from the long periods between these dates from within or around Kunming. If *Cuora yunnanensis* indeed used to occur there naturally, local people would most certainly be able to provide information of the kind they can offer on *Cynops wolterstorffi*. Locals should also be able to identify the species, but none of that is the case. Furthermore, the collection at the University of Kunming would be sure to contain reference material.

Did the search effort fail because all searches took place in the wrong area? It appears very likely in the light of the sudden appearance of the live female.

Let us now look at the second locality of a *Cuora yunnanensis,* i.e., that of specimen BMNH 1946.1.22.97 from Dongchuan (26°11'N, 103°03'E). Owing to its climatic conditions, the surroundings of Dongchuan would be far better suited as a distribution range for a turtle than the Kunming area. Although Dongchuan is situated at 1878 m a.s.l. altitude, it lies immediately adjacent to the 695 m a.s.l. river valley of the Xiaojiang which is a direct, about 185 km-long and 15 to 50 m deep tributary of the Jinsha section of the Yangtze. Following www.wetter online.de, temperatures above 25 °C are more commonly experienced here, which is not the case in Kunming where 20 °C are exceeded only on exceptional summer days. Unfortunately though, there seem to be no long-term weather records for Dongchuan.

It is a small town that was never directly connected to the major trade routes and never played a role as a centre of trade. It is therefore much more likely that specimen BMNH 1946.1.22.97 indeed originated from the vicinity of Dongchuan.

TANG (pers. comm.) visited Dongchuan in March 2005 in an attempt to locate *Cuora yunnanensis.* He interviewed locals of up to 90 years of age living in the vicinity of the Xiaojiang and other areas. As it turned out, they had never seen any turtle in the region. According to his account, the area is also unsuitable for turtles (now) as the river and its tributaries are heavily polluted. They have furthermore undergone drastic alterations and been built over as have the adjacent lands (Fig. 20). TANG also visited possible habitats along the Jinsha-jiang (a section of the Yangtze-kiang) within the municipality of Dongchuan where it represents the boundary between the provinces of Yunnan and Sichuan, but was equally unsuccessful there (Fig. 21). Both localities are therefore quite unlikely to have been the actual point of origin of this species.

The present author now presumes that *Cuora yunnanensis* may actually have occurred, or still occurs, in the southern parts of Sichuan Province, i.e., near Dongchuan and still within the reaches of the Yangtze delta. Does the existence of the live female prove that the species still lives there? This area has a moderate altitude (200 to 1,200 m a.s.l.) and appears to have a much more favourable climate for turtles than both the Kunming Plateau and the Dongchuan area (comp. Map 1). Intense field studies in this region would be required to prove or disprove this presumption.

A Hong Kong-based animal dealer who also undertook a search for *Cuora yunnanensis* is believed to have found a shell of this species in this region (TANG pers. comm.). This information has, however, not been verified as yet.

Status, conclusions and suggestions

Until final research results (e.g., on the basis of a DNA analysis of the live specimen, an actual record from the wild, or the find of a specimen in a breeding farm as counter evidence) become available it has to be presumed that *Cuora yunnanensis* is indeed a valid species. It has the components of a genuine miracle that following nearly one-hundred years without confirmation a live specimen appears, and that this happens at a point of time when 80 % of all Asiatic pond turtles are seriously threatened by extinction. The unfortunate aspect is that the appearance of a live *Cuora yunnanensis* has triggered a „*yunnanensis* mania". Various animal dealers from Hong Kong and Japan are currently scouring the surroundings of Kunming and other parts of Yunnan, including the type locality Dongchuan, for more specimens. They have been offering high rewards to the local populace which in itself carries a potential for the complete eradication of the species within a very short period of time.

It would therefore be necessary to raise the protection status for this turtle even more and effect severe penalties for illegally trading this species in China. Intense scientific fieldwork is required to locate and subsequently protect the populations that may have survived as well as their natural habitats.

Acknowledgements

I would like to thank FRANZ TIEDEMANN and RICHARD GEMEL (NMW, Vienna), as well as COLLIN MCCARTHY (BMNH, London/England) for allowing me to access the specimens housed at the NMW, respectively the type series at the BMNH. My thanks are also due to ZHAO HUI (Chendgu/China) and ZHOU TING (Nanjing/China) for the excellent photographs of the live *Cuora yunnanensis* and to TANG MICHAEL (Hong Kong/China) for additional photographs of other species, as well as to JAMES F. PARHAM (Berkeley/USA) for photographs of the *Cuora pani* type specimens. I am grateful to CARL H. ERNST (Fairfax/

USA) and JOHN B. IVERSON (Richmond/USA) for making available to me their collections of data. NORBERT STRAUSS (Dörnbach/Austria) provided me with a video he taped at the University of Kunming. I thank JAMES BARZYK (Houston/USA), ROGER BOUR (MNHN, Paris/France), PETER PAUL VAN DIJK (Selangor/Malaysia), CARL H. ERNST (Fairfax/USA), FU JINZHONG, HOU MIAN (Chengdu/China), JAKOB HALLERMANN (ZMH, Hamburg/Germany), JOHN B. IVERSON (Richmond/USA), MICHAEL LAU (Hong Kong/China), COLLIN MCCARTHY (BMNH, London/England), WILLIAM P. MCCORD (New York/USA), JAMES F. PARHAM (Berkeley/USA), HANS-DIETER PHILIPPEN (Heinsberg/Germany), PHILLIP SPINKS (Davis/USA), TANG MICHAEL (Hong Kong/China), YANGJI (Kunming/China), ZHAO ERMI (Chendgu/China) and ZHOU TING (Nanjing/China) for their discussing with me in detail various aspects of the present subject, valuable criticism, information, and making available partly difficult-to-access literature. I would also like to again express my gratitude to BRIAN LU (Macao), TANG MICHAEL (Hong Kong/China) and MICHAEL LAU (Hong Kong/China) and the staff at Kadoorie Farm for their translations of Chinese publications.

Bibliography

BLANCK, T.: Ein detaillierter morphologischer Vergleich von *Cuora trifasciata*, *Cuora pani* & *Cuora aurocapitata* mit *Cuora yunnanensis* und *Cuora flavomarginata* - Ein Widerspruch zu den genetischen Analysen? – In Vorb.

BLANCK, T. & G. SCHAFFER: Schildkröten-Hybriden Teil 2: Hybriden der Gattung *Cuora*. – Sacalia, Stiefern. In Vorb.

BLANCK, T. & M. TANG: Ein neuer Fundort von *Cuora pani* SONG, 1984 mit Diskussion über den taxonomischen Status von *Cuora pani* und *Cuora aurocapitata*. – Sacalia, Stiefern. In Vorb.

BOULENGER, G. A. (1905): Description of a new newt from Yunnan. – Proc. Zool. Soc., London, **2** (1905): 277-278.

BOULENGER, G. A. (1906): Descriptions of new reptiles from Yunnan. – Ann. Mag. Natur. Hist., London, **7** (17): 567-568.

ERNST, C. H. (1988): Redescriptions of two Chinese *Cuora* (Reptilia: Testudines: Emydidae). – Proc. Biol. Soc., Washington, **101**(1): 155-161.

ERNST, C. H. & W. P. MCCORD (1987): Two new turtles from Southeast Asia. – Proc. Biol. Soc., Washington; **100** (3): 624-628.

ERNST, C. H. & R. W. BARBOUR (1989): Turtles of the World. – Smithsonian Inst. Press (Washington D.C. & London), 313 S.

ERNST, C. H., R. G. M. ALTENBURG & R. W. BARBOUR (2000): Turtles of the World. – Biodiversity Center ETI, Multimedia Interactive Software, Springer Verlag/Unesco (Paris) (CD-Rom).

FENG, Z.-J., S.-C. ZOU, C.-F. CHEN & Y.-Y. ZHAO, (2004): General review of study of *Cuora* in China, with comments on the conservation of *Cuora aurocapitata*. – Sichuan J. Zool., Chengdu, **23** (3): 243-248 (in chinesisch).

FONG, J. J, PARHAM, J. F. & FU, J. (2002): A reassessment of the distribution of *Cuora flavomarginata* GRAY, 1863 on mainland China. – Russ. J. Herpetol., St. Petersburg, **9** (1): 9-14.

FORNELINO, M. M. (1992): El maravilloso mundo de las tortugas. – Madrid (Ed. Antiquaria), 479 S.

FRITZ, U. (2001): *Emys orbicularis* (LINNAEUS, 1758) – Europäische Sumpfschildkröte. – In FRITZ, U. (Hrsg.): Handbuch der Reptilien und Amphibien Europas. Band 3/IIIA – Schildkröten (Testudines) I (Bataguridae, Testudinidae, Emydidae). – Wiebelsheim (Aula Verlag), 594 S.

HAITAO, S. (2002): Results of turtle market surveys in Chengdu and Kunming. – Turtle Tortoise Newsletter, Lunenburg, 6: 15-16.

HAMBURGER, J. (1999): The Role of Science in Environmental Management: Case Studies from Three Plateau Lakes in Yunnan Province, China. – Sinosphere, Ann Arbor, **2** (3): 3-6.

IVERSON, J. B. (1992): A Revised Checklist with Distribution Maps of the Turtles of the World. – Richmond (Selbstverlag), 363 S.

JOSEPH-OUNI, M. (2003): Profiles of Extinction # 1: Yunnan Box Turtle *Cuora yunnanensis*. – Reptilia (GB), Barcelona, 27: 3.

MCCORD, W. P. & J. B. IVERSON (1991): A new box turtle of the genus *Cuora* (Testudines: Emydidae) with taxonomic notes and a key to the species. – Herpetologica, Emporia, **47** (4): 407-420.

MCCORD, W. P. & M. JOSEPH-OUNI (2002): Chelonian Illustrations: Asian box turtles. – Reptilia (GB), Barcelona, 22: 31-33.

MENG, X. & G. SHI (2002): Identification Manual for Common Turtles and Tortoises, by CNMA. – CITES Management Authority China, Beijing (China Forestry Publishing House), 174 S.

MENGWEN, Z., Y. ZANG & M. JIFAN (1998): FAUNA SINICA, Reptilia Vol. 1: General Accounts of Reptilia, Testudoformes and Crocodiliformes. – Science Press, Beijing (Vol.1.): 118, 119 & 313 (Tafel; in chinesisch), 214 S.

MÜLLER, M. J. (1996): Handbuch ausgewählter Klimastationen der Erde. – Trier (Universität Trier, Forschungsstelle Bodenerosion Mertesdorf), 400 S.

PARHAM, J. F., B. L. STUART, R. BOUR & U. FRITZ (2004): Evolutionary distinctiveness of the extinct Yunnan box turtle (*Cuora yunnanensis*) revealed by DNA from an old museum specimen. – Proc. R. Soc. B (Suppl.), Biol. Letters, London, 271: 391-394 + Electr. App. A, 6 S.

POPE, C. H. (1935): The Reptiles of China: Turtles, Crocodilians, Snakes, Lizards Natural History of Central Asia. – Amer. Mus. Nat. Hist., New York, Vol. 10, XLVII + 604 S.

PRITCHARD, P. C. H. (1979): Encyclopaedia of Turtles. – TFH Publications (Neptune City), 895 S.

ROGNER, M. (1995): Schildkröten 1. Chelydridae, Dermatemydidae, Emydidae. – Hürtgenwald (Heidi Rogner-Verlag), 192 S.

SCHILDE, M. (2004): Asiatische Sumpfschildkröten. Die Familie Geoemydidae in Südostasien, China und Japan. – Münster (Natur und Tier - Verlag), 192 S.

SIEBENROCK, F. (1909): Synopsis der rezenten Schildkröten mit Berücksichtigung der in historischer Zeit ausgestorbenen Arten. – Zool. Jahrb., Wien, Suppl. 10: 427-618.

SMITH, M. A. (1931): The Fauna of British India, including Ceylon and Burma. Reptilia and Amphibia. Vol. 1. Loricata, Testudines. – Taylor & Francis (London), 185 S.

SONG, M. (1984): A new species of the turtle genus *Cuora* (Testudoformes: Testudinidae). Acta Zootaxonomica Sinica, Xi'an, **9** (3): 330-332. (in chinesisch)

WERMUTH, H. & R. MERTENS (1961): Schildkröten, Krokodile, Brückenechsen. – Jena (Gustav Fischer Verlag), XXVI + 422 S.

XIANGKUI, Y. (1999): Fossil and Recent Turtles of China. – Science Press, Beijing, 112 S.

YANG, D.-Y. & D.-Y. TANG (1998): Atlas for Chinese chelonians original colour. – Guangzhou (Economy Publ. Comp. Guangdong). (in chinesisch)

YASUKAWA, Y., R. HIRAYAMA & T. HIKIDA (2001): Phylogenetic relationships of the geoemydine turtles (Reptilia: Bataguridae). – Current Herpetol., Kyoto, **20** (2): 105-133.

ZHANG, X. & Q. CHENG (1946): Records of Reptiles in Sub-urban of Kunming. – Sino France Culture, National Beiping (Beijing), Acad. Publ. (Institute Zool. Chin. Acad. Sci.), Fauna Research Center, **1** (8): 2-8 (in chinesisch).

ZHAO, E. (1998): China Red Data Book of endangered animals. Vol. 3: Amphibia & Reptilia. – Beijing (Science Press), 330 S.

ZHAO, E., J. ZHOU & T. ZHOU (1997): Chinese Chelonian Research. – Herpetol. Series 9, Nanjing (Science & Technology Publishing House), 156 S.

ZHOU, J. & T. ZHOU (1992): Chinese Chelonians Illustrated. – Nanjing (Jiangsu Sci. Technol. Publ. House), 89 S.

ZHOU, T. (2004): Atlas of Identification of Turtles and Tortoises. – Bejing (Agriculture Publ. Comp. China), 284 S. (in chinesisch).

ZHOU, T. & E. ZHAO (2004): On the occurrence of living *Cuora yunnanensis* since fifty-eight years and its description. – Sichuan J. Zool., Chengdu, **23** (4): 325-327 + 1 Fototafel (in chinesisch).

ZHOU, T., H.-X. GU & Z.-L. OU (2004): The Visual Turtles: Keeping and Appraisal. – Shanghai (Technol. Publ. Comp.), 136 S. (in chinesisch).

Internet resources

IUCN (2000): IUCN Red List of Threatened Species. – www.redlist.org

MÜHR, B. (2000): Klima in Kunming. – www.klimadiagramme.de

US EMBASSY BEIJING (2000): Dianchi: Anatomy of a Polluted Chinese Lake. – www.usembassy-china.org.cn/sandt/Dianchi.htm

WETTERONLINE (2005): Klimadaten von Dongchuan und Kunming. – www.wetteronline.de

XIE, Y., S. WANG, F. HE & E. ZHAO (2001): China Species Information System. – www.chinabiodiversity.com

Author

Torsten Blanck
Holleneggerstraße 15
8530 Deutschlandsberg
Austria
E-Mail: Cuora_yunnanensis@yahoo.com

Author's note: The names of Chinese contact persons are given in Chinese style according to which the family name comes first.